



Illinois Department of Transportation

Memorandum

To: ALL BRIDGE DESIGNERS 97.3

From: Ralph E. Anderson *Ralph E. Anderson*

Subject: Metric Guidelines

Date: April 30, 1997

This bridge memorandum supersedes the previously issued Bridge Memorandums 93.3 and 93.6 which pertained to interim metric guidelines. Metric policies which are not specifically stated in the Metric Bridge Manual, Metric Prestressed Concrete Manual and the Metric CADD Manual are stated or referenced to other metric documents in this memorandum.

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General Guidelines

1. All plans, including shop plans, should be in metric units only. Do not use dual units.
2. Use only millimeters (mm) and meters (m) for length measurements.
3. Use a general note "All dimensions are in millimeters (mm) except as noted". This will eliminate the repetitive use of (mm).
4. All measurements of one (1) meter and larger should be detailed in meters (m) and decimals of a meter. All measurements smaller than one (1) meter shall be detailed in millimeters (mm).
5. Soft metric means no physical change is required (conversion to the nearest one (1) millimeter). Hard metric means the product requires physical change (conversion to a convenient and practical measurement).

Rules for Writing Metric Symbols and Names

1. Print decimal prefixes in lower case for magnitudes 10^3 and lower (this is k, m, μ , and n) and print the prefixes in upper case for magnitudes 10^6 and higher (this is, M and G).
2. All unit symbols are lower case except for liter (L) and those derived from proper names such as Newton (N).
3. Leave a space between a numeral and a symbol (write 45 kg or 37 °C, not 45kg or 37°C or 37° C).
4. Always use decimals, not fractions (write 0.75 g, not $\frac{3}{4}$ g).
5. Use a zero before the decimal marker for values less than one (write 0.45 g, not .45 g).
6. Do not leave a space between a unit symbol and its decimal prefix (write kg, not k g).
7. Do not use the plural of unit symbols (write 45 kg, not 45 kgs), but do use the plural of written unit names (several kilograms).
8. For technical writing, use symbols in conjunction with numerals (the area is 10 m²); write out unit names if numerals are not used (carpet is measured in square meters). Numerals may be combined with written unit names in nontechnical writing (10 meters).
9. Indicate the product of two or more units in symbolic form by using a dot positioned above the line (kg·m s²).
10. Do not mix names and symbols (write N·m or newton meter, non N meter or newton·m).
11. Do not use a period after a symbol (write “12 g”, not “12 g.”) except when it occurs at the end of a sentence.

Decimal prefixes to the tertiary power of 10 are preferred. The prefixes deci (d) for one tenth (10^{-1}), centi (c) for one hundredth (10^{-2}), deca (da) for ten (10^1), and hecto (h) for one hundred (10^2) have limited application in construction.

METRIC PRACTICE

LOADING		<u>Metric</u>	<u>(English)</u>
Truck		MS18	(HS20)
Front Axle		36 kN	(8 kips)
Rear Axle		142 kN	(32 kips)
Axle Spacing	Minimum	4.2 m	(14 ft.)
	Maximum	9.2 m	(30 ft.)
Wheel Spacing		1.8 m	(6 ft.)
Alternate Truck			
Axle		107 kN	(24 kips)
Axle Spacing		1.2 m	(4 ft.)
Lane Loading			
Distributed Load over 3 m		9.3 kN/m	(0.64 k/ft)
Concentrated Load		80 kN	(18 kips)
		116 kN	(26 kips)
Dead Load			
Future Wear Surface		1.2 kN/m ²	(25 psf)
Unit Weights			
Reinforced Concrete		23.6 kN/m ³	(150 pcf)
Structural Steel		77.0 kN/m ³	(490 pcf)
Soil		18.8 kN/m ³	(120 pcf)
Lateral Soil Pressure			
Equivalent fluid weight		6.3 kN/m ³	(40 pcf)

MATERIAL STRENGTH

Structural Steel M-270M

Grade	Tensile Strength MPa (ksi)	Min. Yield Strength MPa (ksi)
250 (36)	400-550 (58-80)	250 (36)
345 (50)	450-(65)	345 (50)
345W (50W)	485 (70)	345 (50)

Concrete

Compressive Strength

MPa (psi)
24 (3500)
28 (4000)
35 (5000)
42 (6000)

Reinforcement Bars (M 31M, M 42M, M 53M)

Grade	Tensile Strength MPa (ksi)	Min Yield Strength MPa (ksi)
300 (40)	500 (70)	300 (40)
400 (60)	600 (90)	400 (60)
500 (75)	700 (100)	500 (75)

Bar Lengths

Give lengths of straight bars and straight portions of bent bars to the nearest 10 mm.

Bar Spacings

Detail in increments of 10 mm

PILES

Length

Nearest 0.5 m

Capacity (friction piles)

200 – 500 kN; increments of 50 kN.
(10 kN increments permitted when analysis is based on actual design loads)

SPREAD FOOTINGS

Qmax.	KPa (psf)
Thickness	Minimum 450 mm; increments of 50 mm

SURVEYING

Angles	Degree (⁰), minute (') and second (") continue in use.
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QUANTITIES

ITEM	UNIT ACCURACY
Concrete Removal	0.1 m ³
Concrete Structures	0.1m ³
Porous Granular Embankment	m ³
Structure Excavation	m ³
Joints	0.1 m
Protective Coat	m ²
Structural Steel	10 kg
Reinforcement Bars, Epoxy Coated	10 kg
Slope Wall	m ²
Slope Wall Removal	m ²
Piles	0.5 m
Caisson Shafts	0.1 m ³
PPC I-Beam	0.5 m
Temporary Sheet Piling	0.1 m ²
Railing	0.5 m
Riprap	m ²
Precast Box Culverts	0.5 m
Concrete Repairs	0.1 m ²
Bridge Deck Grooving	m ²
Overlays	m ²

REHABILITATION

When existing English structural members are to be incorporated into a Rehabilitation project with metric units, they shall be labeled with their English Designation and clearly marked as "existing" and "English".

Example: Existing 27WF84 (English)

If significant information from an existing structure with English units is required, a separate sheet may be used to show all necessary information in English units provided the sheet is clearly labeled "FOR INFORMATION ONLY".

PLANNING

Bridge Widths

Lane		
Typical Ramp	4.9 m	(16 ft.)
Traffic Lanes	4.2 m	(14 ft.)
	3.6 m	(12 ft.)
	3.3 m	(11 ft.)
Stage Construction (min.)	3.0 m	(10 ft.)

Shoulders	1.2 m	(4 ft.)
	1.8 m	(6 ft.)
	2.4 m	(8 ft.)
	3.0 m	(10 ft.)

Vertical Clearance

Highway		
Urban	4.5 m	(14 ft. 6 in.)
Rural	5.0 m	(16 ft. 3 in.)
Railroad	7.0 m	(23 ft.)
Freeboard	600 mm	(2 ft.)

Bridge Span Lengths Nearest 0.01 m

Bridge Stationing Nearest millimeter

Horizontal Clearance

Highway		
E.P. to Face of Abut.	9.0 m	(30 ft.)
Railroad*		
Centerline RR to Slope	6.75 m	(22 ft.)
Centerline RR to Pier	3.7 m	(12 ft.)
Centerline RR to min Vertical Clr. Point	2.45 m	(8 ft.)

*These dimensions will be established by other agencies. The limiting values shown should be used for the item.

Bolt Comparison

English				Metric	
Bolt Diameter		Standard Hole		Bolt Diameter	Standard Hole
in	mm	in	mm	mm	mm
1/2	12.7	9/16	14.3	-	-
5/8	15.9	11/16	17.5	M16	18
3/4	19.0	13/16	20.6	-	-
-	-	-	-	M20	22
7/8	22.2	15/16	23.8	M22	24
-	-	-	-	M24	27
1	25.4	1 1/16	27.0	-	-
1 1/8	28.6	1 3/16	30.2	M27	30
1 1/4	31.8	1 5/16	33.3	M30	33
1 3/8	34.9	1 7/16	36.5	-	-
-	-	-	-	M36	39
1 1/2	38.1	1 9/16	39.7	-	-

Based on the information in the above table, the following table shows the permissible direct bolt substitutions.

Metric Bolt mm	English Substitution In
M16	5/8
M22	7/8
M27	1 1/8
M30	1 1/4

Nominal Hole Dimensions, mm

Bolt Diameter	Standard	Oversize	Short slot	Long slot
M16	18	20	18 x 22	18 x 40
M20	22	24	22 x 26	22 x 50
M22	24	28	24 x 30	24 x 55
M24	27	30	27 x 32	27 x 60
M27	30	35	30 x 37	30 x 67
M30	33	38	33 x 40	33 x 75
<u>≥</u> M36	d + 3	d + 8	(d+3) x (d+10)	(d+3)x2.5d

Other Pertinent Metric Documents:

- *A Guide for Metric Steel Fabrication*, American Institute of Steel Construction, Inc.
- *Metric Properties of Structural Shapes with Dimensions According to ASTM A6M*, American Institute of Steel Construction, Inc.
- *Standard Specifications for Highway Bridges, Appendix E*, American Association of State Highway and Transportation Officials.
- *Special Provision for English Substitution of Metric Reinforcement Bars*, State of Illinois, Department of Transportation.
- *Special Provision for English Substitution of Metric Bolts*, State of Illinois, Department of Transportation.
- *Metric Culvert Guidelines*, State of Illinois, Department of Transportation.
- *Metric Noise Wall Design Criteria*, State of Illinois, Department of Transportation.